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April 13, 1995

BY HAND DELIVERY

Mr. William F. Caton
Acting Secretary
Federal Communications Commission
1919 M Street, N.W.
Washington, D.C. 20554

Re: Ex Parte Presentation
CC Docket No. 92-297

Dear Mr. Caton:

On April 13, 1995, representatives of Teledesic Corporation ("Teledesic") met with a Federal Communications Commission ("Commission") representative to discuss matters related to issues addressed in Teledesic's comments and reply comments in ET Docket No. 94-124 and written ex parte filings in CC Docket No. 92-297. In the course of the meeting, the attached document, "Designating the 40.5 - 42.5 GHz Band For LMDS And Preserving The Ka Band For FSS Will Create A Win-Win Situation For Wireless Cable, The Satellite Industry and Equipment Manufacturers" was distributed and discussed. Teledesic was represented by Russell Daggatt, President, Larry Williams, Director of External Affairs, and Janice Obuchowski of Freedom Technologies. The Commission was represented by Regina Keeney, Chief, Wireless Telecommunications Bureau.

Pursuant to Section 1.1206(a)(1) of the Commission's Rules, an original and two copies of this letter and its attachment are enclosed. Copies of this letter are being provided simultaneously to the Commission representative identified above.

Very truly yours,

Jennifer A. Manner

cc: Ms. Regina Keeney

DESIGNATING THE 40.5 - 42.5 GHz BAND FOR LMDS AND PRESERVING THE Ka BAND FOR FSS WILL CREATE A WIN-WIN SITUATION FOR WIRELESS CABLE, THE SATELLITE INDUSTRY AND EQUIPMENT MANUFACTURERS

Presented by Teledesic Corporation
April 1995
Washington, D.C.

DESIGNATING THE 40.5 - 42.5 GHz BAND FOR LMDS AND PRESERVING THE Ka BAND FOR FSS WILL CREATE A WIN-WIN SITUATION FOR WIRELESS CABLE, THE SATELLITE INDUSTRY AND EQUIPMENT MANUFACTURERS

- **GLOBAL, INTERACTIVE BROADBAND SATELLITE SYSTEMS ARE ESSENTIAL TO THE NATIONAL INFORMATION INFRASTRUCTURE/GLOBAL INFORMATION INFRASTRUCTURE AND UNIVERSAL SERVICE OBJECTIVES**

- **THE Ka BAND IS THE ONLY SPECTRUM SUITABLE FOR THE DEPLOYMENT OF GLOBAL, INTERACTIVE BROADBAND SATELLITE SYSTEMS**

- **SHARING BETWEEN SATELLITE AND LMDS IN THE Ka BAND IS NOT TECHNICALLY FEASIBLE**

- **DESIGNATING THE 40.5 - 42.5 GHz BAND TO LMDS WILL CREATE A WIN-WIN SITUATION FOR WIRELESS CABLE, THE SATELLITE INDUSTRY, AND EQUIPMENT MANUFACTURERS**

- **LMDS OPERATION IN THE 40.5 - 42.5 GHz BAND IS TECHNICALLY AND ECONOMICALLY COMPARABLE TO SUCH OPERATION IN THE Ka BAND**

- **THE EUROPEAN EXPERIENCE DEMONSTRATES THAT 40.5 - 42.5 GHz LMDS IS TECHNICALLY AND ECONOMICALLY ACHIEVABLE**

- **THE 28 GHz PROCEEDING MUST BE CONCLUDED PRIOR TO WRC-95**

DESIGNATING THE 40.5 - 42.5 GHz BAND FOR LMDS AND PRESERVING THE Ka BAND FOR FSS WILL CREATE A WIN-WIN SITUATION FOR WIRELESS CABLE, THE SATELLITE INDUSTRY AND EQUIPMENT MANUFACTURERS

I. GLOBAL, INTERACTIVE BROADBAND SATELLITE SYSTEMS ARE ESSENTIAL TO THE NATIONAL INFORMATION INFRASTRUCTURE/GLOBAL INFORMATION INFRASTRUCTURE ("NII/GII") AND UNIVERSAL SERVICE OBJECTIVES

- **As Vice President Gore stated, the "most important principle" of the Global Information Infrastructure ("GII") "is to ensure universal service so that the GII is available to all members of our societies."**

  - Traditional wireline technologies are unable to deliver even the most basic telecommunications services to most of the world.

  - Many countries, particularly in the developing world, would have a very limited long distance network and would be virtually cut-off from international communications were it not for satellites.

  - Most of the world's citizens will never have access to advanced, digital broadband information capabilities through a wireline infrastructure.

  - Outside the urban areas of the United States and other developed countries, and perhaps a few major cities in the developing world, most of the world including rural and remote portions of the United States will receive affordable access to advanced information services only through a satellite-based broadband network.

- **Promoting the deployment of global, broadband satellite systems will ensure that true universal service is available at affordable prices to all the world's citizens regardless of geographic location.**

- George Gilder: "no terrestrial system will cover the entire world, or even the entire U.S., within decades of Teledesic. As soon as it is deployed, it will profoundly change the geography and topography of the globe. Suddenly the most remote rural redoubt, beach or mountain will command computer communications comparable to urban corporations. The system can make teleconferencing, telecommuting, telemedecine, and teleschooling possible anywhere. Gone will be the differences among regions in access to cultural and information resources. People will be able to live and work where they want rather than where corporations locate them." Gilder, Telecosm Ethersphere, Forbes ASAP, Oct. 10, 1994, at 133, 146 (attached hereto as Attachment A).

II. THE Ka BAND IS THE ONLY SPECTRUM SUITABLE FOR THE DEPLOYMENT OF GLOBAL, INTERACTIVE BROADBAND SATELLITE SYSTEMS

- **In 1971, the Ka band (27.5 - 30.0 GHz uplinks and 17.7 - 20.2 GHz downlinks) was allocated internationally for the Fixed Satellite Service ("FSS").**

  - Office of Science and Technology Policy, Office of the President ("OSTP"): "international frequency allocations support Fixed Satellite Service (FSS) in this ["the ka"] band ... Any loss of FSS access to Ka Band in the U.S. could prevent U.S. industry from aggressively moving into this band, resulting in the loss of service and manufacturing markets to overseas competitors." Letter to Chairman Reed E. Hundt from Lionel S. Johns, OSTP, at 1 (Dec. 2, 1993) ("OSTP Letter").

- **Satellite systems are intrinsically global in scope and require a global allocation of spectrum.**

  - The Ka band is the only portion of the spectrum that is suitable for the deployment of global, interactive broadband satellite systems.

  - The Ka band is the band that is being used in countries throughout the world for the deployment of broadband global satellite systems.

-- To date, 149 Ka band satellite systems have been advanced published, are under coordination or have been notified. Of these, 33 have reached the notification stage and have either been deployed or are likely to be deployed soon. These satellite systems have been deployed or proposed by Australia, Belgium, Canada, the European Space Administration, France, Germany, Italy, Japan, Russia and the former Soviet Union, the United Kingdom and the United States.

-- By the end of 1997, for example, the presumption is that the 33 geostationary satellites presently notified will be brought into service in the Ka band.

o **Satellites require global allocations in both the uplink and downlink frequencies. The local multipoint distribution service ("LMDS") is local and does not require a global allocation of spectrum. Therefore, the FCC has flexibility in locating LMDS.**

- Hughes Communications Galaxy, Inc. ("Hughes"): "Most other countries ... have recognized that LMDS systems are quite viable in a number of other bands and either have proposed one or more of these other bands or have adopted the 40 GHz for LMDS-type services." Hughes Comments, at 12.[1]

o **If the United States fails to preserve the Ka band for broadband satellite service, U.S. companies will be excluded from the global satellite market and broadband satellite systems will not be deployed.**

- National Telecommunications and Information Administration ("NTIA"): "Regulatory actions that substantially limit future FSS developments could put the United States at odds with the implementation of existing worldwide allocations, and place U.S. industry at a disadvantage in the international marketplace. Furthermore, the search for additional FSS allocations, if a domestic shortfall in usable spectrum occurs, would be difficult." Letter to Kathleen Levitz, FCC from Richard D. Parlow, NTIA, at 3-4 (July 20, 1993) ("NTIA Letter").

1. All comments and reply comments cited herein were filed in ET Docket No. 94-124 unless otherwise noted.

III. SHARING BETWEEN SATELLITE AND LMDS IN THE Ka BAND IS NOT TECHNICALLY FEASIBLE

- **In 1993, pursuant to a petition by LMDS proponents, the FCC proposed to modify its rules to redesignate the lower 2 GHz of the Ka uplink band (i.e., 27.5 - 29.5 GHz) ("the 28 GHz band") to LMDS.**

  - FCC: At the time of this proceeding, "the Commission observed that CellularVision was then serving only about 200 customers and that its claim to the public interest use of the 28 GHz remained largely unproven." FCC Reply to CellularVision Writ of Mandamus, No. 95-1030, at 7.

  - At the initiation of the rulemaking, the FCC recognized "that redesignation of the point-to-point use of the [28 GHz] band to point-to-multipoint use could stimulate greater use of a band that largely has lain fallow." Rulemaking to Amend Part 1 and 21 of the Commission's Rules to Redesignate the 27.5 - 29.5 GHz Band and to Establish Rules and Policies for Local Multipoint Distribution Service, 9 FCC Rcd 1394 (1994) ("28 GHz Proceeding").

  - This assumption is no longer valid because there are various proposals for global satellite use of the Ka band.

- **Because of serious concerns over whether the proposed LMDS and FSS could share the 28 GHz band, the FCC established a Negotiated Rulemaking Committee ("NRMC") in 1994 to determine whether co-frequency sharing of the 28 GHz band between the FSS and the proposed LMDS was possible. LMDS operations also threatened to interfere with another FCC initiative, the establishment of mobile satellite systems.**

  - NRMC: After thoroughly considering and evaluating numerous sharing proposals, the NRMC concluded that none of the proposed solutions were "deemed feasible by any combination of LMDS and FSS proponents." Report of the LMDS/FSS 28 GHz Negotiated Rulemaking Committee, at 85 (Sept. 23, 1994) ("NRMC Report").

    -- Bill Luther, NRMC Facilitator: "My conclusion is that the analysis shows that [FSS and LMDS] sharing is really not possible." Committee Fails to Agree on Solution for Satellite Interference to LMDS, Communications Daily, Sept. 27, 1994, at 1.

-- NTIA: "NTIA believes that co-channel sharing in the same operating areas between LMDS services and transmitting earth stations operating in the fixed-satellite service (FSS) would be very difficult, requiring technical modifications or limitations to the LMDS implementation proposals, and will require careful coordination between stations in the two services." NTIA Letter, at 1.

- NRMC: The results of the engineering analyses demonstrated that the degree of interference from FSS earth station transmitters into LMDS receivers is overwhelming and "results from the proposed widespread distribution of both FSS Earth stations and LMDS receivers throughout the same geographic area". NRMC Report, at 85.

o **The Suite 12 and Motorola "sharing" agreement is in reality a band segmentation agreement and demonstrates the sheer magnitude of the interference problem between LMDS and FSS.**

- During the NRMC, Suite 12 and Motorola signed a private agreement which provided for the contemporaneous operation in the 28 GHz band of Motorola's Mobile Satellite Service ("MSS") feeder links and LMDS.

- Despite the claims of Suite 12, the agreement does not provide any sharing solution between LMDS and MSS feeder links. To the contrary, the agreement clearly demonstrates the disadvantages of frequency sharing between LMDS and MSS feeder links (a type of FSS use).

- The Motorola system will only operate two to three MSS feeder link Earth stations in all of the United States. In these cases, the "sharing" agreement requires a 75 nautical mile separation of LMDS sites from the MSS feeder link Earth stations. Even with this limitation it is still required that the return links accept harmful interference in MSS frequencies.

-- Pursuant to the agreement, LMDS sites operating in the 29.1 - 29.5 GHz band within a radius of 75 nautical miles of the MSS feeder link Earth stations are required to accept any interference caused to them by the MSS feeder link Earth stations. "Views of NRMC Members Supporting Motorola-Suite 12/CVNY Rule Proposal in the Form of Their Version of Section VI to Report of Working Group 2," NRMC/84 (rev. 1), at 13 (Sept. 23, 1994).

-- Under the terms of the agreement, band segmentation is required; Suite 12 is prohibited from operating its subscriber return links in any portion of the frequency band, i.e., 29.1 - 29.5 GHz, that Motorola has proposed for its feeder links.

o **The "Bellcore study" is nothing but a propaganda exercise. Bellcore is a partisan in this debate. The study was paid for by CellularVision and they announced their conclusions at the time the study was commenced.**

- The "Bellcore study" has not been made publicly available despite requests for it. Therefore, no one has been able to evaluate it on the merits.

o **In contrast to LMDS, satellite can share with the existing terrestrial allocation in the Ka band -- fixed point-to-point microwave. However, neither FSS nor terrestrial fixed point-to-point microwave can share with LMDS.**

V. DESIGNATING THE 40.5 - 42.5 GHz BAND TO LMDS AND PRESERVING THE Ka BAND FOR FSS WILL CREATE A WIN-WIN SITUATION FOR WIRELESS CABLE, THE SATELLITE INDUSTRY, AND EQUIPMENT MANUFACTURERS

o **Because co-frequency sharing of the Ka band is not possible, unless other spectrum is made available for LMDS, the FCC may be forced either to segment the Ka band between the FSS and LMDS or permit only one of the services to use the 28 GHz band.**

- LMDS would provide redundant services to areas of high subscriber density that already have, or will have, a number of service options including cable television, direct broadcast satellite, MMDS and video dialtone, at the expense of providing two-way switched broadband services to rural and remote parts of the United States and the world that would otherwise remain unserved.

o **FSS needs an international allocation encompassing both uplink and downlink spectrum. The Ka band is the only currently available frequency band allocated internationally to FSS that provides sufficient uplink and downlink spectrum to operate a global broadband interactive satellite network.**

- **Any assignment of the Ka uplink band to LMDS would orphan an equal amount of the Ka downlink band because downlink spectrum is useless without a matching amount of uplink spectrum.**

- **Both LMDS and the FSS only will be able to realize their full potential if the services are authorized to operate in separate bands. Placing services in separate bands will allow each to realize its full potential without one coming at the expense of the other.**

- **ET Docket No. 94-124 (the "above 40 GHz proceeding") provides the FCC with the opportunity to break the impasse on the future use of the Ka band that presently exists.**

- **Designating the 40.5 - 42.5 GHz band ("41 GHz") band to LMDS in the above 40 GHz proceeding and preserving the Ka band for FSS will create a win-win situation for all affected parties.**

  - Preserves the use of the Ka band for global, interactive broadband satellite systems operating in the FSS.

  - Maximizes the market opportunities for United States FSS and LMDS equipment manufacturers and service providers.

  - Provides LMDS proponents with the amount of spectrum they claim to require to operate their broadcast-type terrestrial service.

  - Is consistent with the worldwide allocation of the Ka band for FSS.

  - Brings the United States into conformance with Europe where spectrum in the 41 GHz band is allocated for LMDS-type service.

- **Designating the 41 GHz band to LMDS in lieu of the 28 GHz band will best serve the public interest because it permits the FCC to accommodate both the spectrum requirements of LMDS and the FSS in separate bands without adversely affecting the deployment of either service.**

  - The U.S. satellite industry will be able to continue to develop Ka band satellite technologies that are being implemented elsewhere in the world and are being tested by the National Aeronautics and Space Administration ("NASA") today in the $1 billion ACTS program.

-- <u>OSTP</u>: "The proposed allocation to satellite use could diminish the ACTs investment and deny the U.S. satellite industry the opportunity to exploit the advantages which this band offers for satellite communications." OSTP Letter, at 1.

-- <u>Committee on Science, U.S. House of Representatives ("House Science Committee")</u>: "A significant national investment of time and resources would be essentially lost in the event that LMDS is allocated spectrum in the 27.5 - 29.5 GHz band, precluding the growth of satellite systems operating over the United States." Letter to Chairman Reed E. Hundt, FCC, from Chairman Robert S. Walker and Ranking Democratic Member George E. Brown, House Science Committee, at 1 (March 6, 1995).

- The U.S. LMDS industry will be able to develop in a manner that is consistent with LMDS systems that are planned for Europe.

- Global equipment markets for both satellite and LMDS components will be fostered by designating the 41 GHz band to LMDS and preserving the 28 GHz band for satellite services.

-- <u>OSTP</u>: "Maintaining consistency between U.S. frequency allocations and the international community will avoid coordination difficulties and will enable U.S. manufacturers to compete in their respective markets on a global basis." OSTP Letter, at 1.

o **There is compelling support in the record to designate the 41 GHz band for LMDS in lieu of the 28 GHz band.**

- <u>NASA</u>: "Use of the 40.5-42.5 GHz band for LMDS in lieu of the 27.5-29.5 GHz band would result in a win-win situation for the American public and American industry." NASA Comments, at 4.

- <u>Boeing Defense & Space Group ("Boeing")</u>: "Authorizing LMDS at the 41 GHz band would create a "Win-Win" solution where both services - LMDS and FSS - can coexist." Letter to Chairman Reed E. Hundt, FCC from C.G. King, Boeing, at 2 (Jan. 9, 1995).

- <u>GE American Communications, Inc. ("GE")</u>: "allocating the 40 GHz frequency band to LMDS would lead to the expeditious offering of both LMDS and Ka-band satellite services." GE Comments, at 8.

- <u>Hughes</u>: "Licensing the 40 GHz band [for LMDS] will provide an opportunity to allow both the LMDS and the satellite industries to develop their proposed broadband services without significantly restricting the operations of either one." Hughes Comments, at 3.

- <u>Martin Marietta Space Group ("Martin Marietta")</u>: "licensing of satellite-incompatible terrestrial services such as LMDS exclusively in the 40 GHz band, while retaining the 28 GHz band exclusively for satellite services, would maximize the overall public benefit by allowing both services to evolve without mutual hindrance or interference." Martin Marietta Comments, at 1.

- <u>Rockwell International Corporation ("Rockwell")</u>: "Designating the 40.5 - 42.5 GHz band for LMDS...will allow the fullest possible implementation of currently proposed LMDS systems and competitive FSS global broadband satellite systems." Rockwell Comments, at 5.

- <u>Teledesic Corporation ("Teledesic")</u>: "the instant proceeding provides the FCC with the opportunity to break the impasse in the proceeding on the future use of the Ka band that presently exists. Designating the 41 GHz band to LMDS will create a win-win situation for all affected parties by providing LMDS proponents with the amount of spectrum they claim to require to operate their broadcast-type terrestrial service, while preserving the use of the Ka band for global, interactive broadband satellite systems operating in the FSS." Teledesic Comments, at 10.

- <u>TRW Inc. ("TRW")</u>: "the Commission has, in the form of the instant proceeding, the ability to provide a satisfactory answer to the satellite/terrestrial sharing issues that hangs over the 27.5-29.5 GHz band." TRW Comments, at 4.

VI. LMDS OPERATION IN THE 40.5 - 42.5 GHz BAND IS TECHNICALLY AND ECONOMICALLY COMPARABLE TO SUCH OPERATION IN THE Ka BAND

- **In comparing the technical and economical feasibility of LMDS at the Ka and the 41 GHz bands, the FCC should not employ a spectrally inefficient analog LMDS system architecture as the standard. More efficient digital LMDS system architectures should be used for the comparison.**

    - Using readily available digital compression techniques (MPEG 2) and digital modulation techniques, 3 to 8 video channels can be transmitted in the same bandwidth that is occupied by one FM video channel of the kind used by CellularVision.

    - In Europe, a digital form of an LMDS-type service is currently being developed which can provide approximately 300 channels in 1 GHz of spectrum in the 41 GHz band.

    - Philips Microwave plans to have LMDS-type 41 GHz digital equipment in production quantities by year end 1996.

- **Even employing an analog LMDS system architecture as the standard for comparison, the majority of commenters have shown that LMDS operation in the 41 GHz band is technically and economically comparable to such operation in the 28 GHz band.**

    - Dudley Labs: Dudley Labs, the largest manufacturer of deployed 28 GHz LMDS equipment and who also manufacturers 41 GHz LMDS equipment, has proposed the movement of 28 GHz LMDS to the 41 GHz band as "technically and in a practical sense possible." Dudley Labs Comments, at 1. Dudley Labs has been "neutral for a long time but [the FCC rulemaking] has been dragging on. We'd like to see it resolved because without licenses we're stuck." Dudley Labs Proposal; Satellite and LMDS React Differently to Latest Spectrum-Sharing Proposal, Communications Daily, Apr. 3, 1995, at 3 ("Dudley Labs Proposal Article").

    - UK Radiocommunications Agency: "by any objective engineering considerations...what works or can be made to work at 28 GHz will work or can be made to work at 40 GHz..." UK Radiocommunications Agency Comments, at 1.

- Massachusetts Institute of Technology, Lincoln Laboratory ("Lincoln Labs"): "Costs for LMDS equipment at higher bands will be higher. However...specific components at issue represent a small portion of overall cost." Dudley Labs Proposal Article, at 3.

- Endgate Technology Corporation ("Endgate"): "Endgate believes that the 40.5-42.5 GHz band can be used effectively for wideband services." Endgate Comments, at 1.

- NASA: "The net effect...would be to create a band at 40.5-42.5 GHz with virtually the same conditions as that proposed at 27.5-29.5 GHz. The same 2 GHz of bandwidth would be established, to be licensed in the same 1,000 MHZ blocks. The propagation environment at 40 GHz is similar to that in the nearby 28 GHz band as are the equipment parameters. Only the name has changed..." NASA Comments, at 4.

- GE: "LMDS as a concept is still largely in the development stage. Accordingly, at this point use of the 40 GHz rather than the 28 GHz frequency band should require relatively minor design and cost considerations, in contrast to the major loss of satellite services if LMDS is permitted to remain at 28 GHz." GE Comments, at 8.

- TRW: "even without considering the obstacles that sharing with satellite providers present, the prospects for terrestrial fiber-optic quality/quantity wideband services are superior at 40 GHz to the prospects at 28 GHz." TRW Comments, at 8.

- Stanford Telecom: "The 40.5 to 42.5 GHz band can provide essentially the same performance characteristics that are currently proposed for typical LMDS systems in the 28 GHz band." Hughes Comments, Appendix A, Stanford Telecom, Review of the Propagation Characteristics in the 28 and 40 GHz Frequency Bands for LMDS Applications, at 1 (1995).

- Teledesic: "LMDS operation in the 41 GHz band is technically comparable to such operation in the Ka band and is readily achievable from both a propagation standpoint and an equipment standpoint." Teledesic Comments, at 13.

o **41 GHz LMDS will utilize the same cell size, same power levels and same antenna as 28 GHz LMDS.**

- Even assuming an analog system architecture as the standard for comparison, the engineering analyses establish that a technically viable 41 GHz LMDS system requires the same number of cells with comparable performance and costs as a 28 GHz band system.

  -- NASA: "We have shown that a 40 GHz LMDS system can be constructed that requires no more hubs than a system at 28 GHz without increasing transmitter powers. The CellularVision claim that 7 times more cells are required at 40 GHz is based upon hardware performance assumptions that are far below what is actually achievable at 40 GHz and at a cost which is within 20% of 28 GHz hardware." NASA Reply Comments, at 13.

  -- GE: "CellularVision can transmit acceptable signals to its subscribers at 40 GHz without decreasing its cells and increasing their number, which it can do by augmenting its present plant with only slight modifications and using transmitters no more powerful than those shown in its links budget ... Alternatively ... by installing two-foot antennas, CellularVision can continue present quality signals out of three-mile cells." GE Reply Comments, at 5.

  -- Hughes: "LMDS can be operated at 40 GHz with cell sizes that are identical to those at 28 GHz and provide essentially the same grade of service...The CellularVision 28 GHz point design (including the 3.0 mile cell radius) can be replicated at 40 GHz at only a 5 to 10 percent additional cost and with only a minor tradeoff in system availability near the edge of the cell. This slight decrease in availability with the same size cell means that LMDS users, at the edge of a cell, could expect service to be below the optimal level about 1.5 hours more per year at 40 GHz than they could expect at 28 GHz." Hughes Reply Comments, at 5.

-- Teledesic: "LMDS operation above 40 GHz will require the same number of cells as 28 GHz LMDS." CellularVision uses in its link budgets for 28 GHz versus 41 GHz LMDS three obvious differences: the transmit power for 50 channels, the transmit antenna coverage and the receive antenna diameter. "Collectively, these differences result in penalizing the 41 GHz system by 7.5 dB. CellularVision uses these biased results to claim that LMDS systems can only operate with 1.15 mile radius cells at 41 GHz as opposed to 3 mile radius cells at 28 GHz. This is the basis of their claim that 7 times as many cells would be required for 41 GHz operation." Teledesic Reply Comments, Appendix A, Apples-to-Apples Comparison Demonstrates the Feasibility of LMDS Above 40 GHz, at 2 and 3-4 ("41 GHz Feasibility Report").

- Rain losses are manageable at 41 GHz and link availability at the 41 GHz band can be achieved at any location in the United States that is comparable to 28 GHz.

-- Teledesic: "Suite 12 has proposed to provide 99.90% rain availability in the 28 GHz band ... for identical hub coverage, for identical transmit power, for identical cell size, and for identical subscriber antenna diameters, a 41 GHz LMDS System operating in New York City provides 99.75% rain availability. This is an inconsequential difference." Teledesic Comments, Appendix A, LMDS is Feasible in the 40.5 - 42.5 GHz Band, at 4 (Jan. 25, 1995). "This is better rain availability then Hughes' commercially successful DIRECTV service [99.7% - 99.8% versus 99.7%]." 41 GHz Feasibility Report, at 4.

-- Stanford Telecom: Alternatively, for identical hub coverage, for identical transmitter power and for identical cell sites, "A receiver antenna of only about 15 inches will achieve the 99.9% level with the 3 mile cell size ... In regard to any concern about the user acceptability of a larger antenna, it must be pointed out that antennas which are 18 inches in diameter are currently being marketed for the new "DSS" system in the United States, and are selling at an extremely fast rate." Hughes Reply Comments, Exhibit A, Stanford Telecom, Assessment of Relative Performance and Costs Between LMDS in the 28 GHz and 40 GHz Bands, at 15 (March 1, 1995).

- Non-line-of-sight operation, foliage attenuation and rain backscatter are the same at both frequencies and are not a factor.

  -- NASA: Based on laboratory experiments at NASA Lewis Research Center to assess the behavior of reflected signals in the 28 GHz to 41 GHz frequency range, NASA "concluded that performance of an LMDS system operating at 40 GHz would be substantially the same as operation at 28 GHz." NASA Comments, at 7-9. Hence, it is not a factor in the selection of an operating frequency.

  -- Lincoln Labs: "Attenuation due to foliage, while high, remains substantially constant in the frequency range between 20 and 44 GHz." Lincoln Labs Comments, at 3. Therefore, it is not a factor in the selection of an operating frequency.

  -- Hughes: Rain backscatter at the 41 GHz band will be lower than at the 28 GHz band. This will reduce the potential for backscatter interference into subscriber antennas and provide better frequency reuse at 41 GHz.

o **41 GHz LMDS equipment is available at costs slightly higher than 28 GHz LMDS equipment; the initial cost increase will quickly disappear over time.**

- The cost of approximately 90% of the elements of an LMDS system will not change if LMDS is deployed at 41 GHz. Modulators, encoders, power supplies, equipment racks, site cost and equipment required to distribute programming to the hub are identical for both 41 GHz and 28 GHz operation.

- Only the RF components will change, i.e., RF portion of hub, hub transmitter (TWTA or SSPA), hub antenna, subscriber antenna and RF of subscriber receiver unit.

  -- Lincoln Labs: "the RF components comprise a small part of the system." Lincoln Labs Comments, at 1.

- 41 GHz equipment components that will change initially will cost 15% to 20% more than 28 GHz components.

- Endgate: "the 41 GHz equipment initially will cost 15% to 20% more than the 28 GHz equipment and the differential will become insignificant over time in much the same way as the price differential between C-band and Ka-band systems has declined." Endgate Comments, at 2.

- Lincoln Labs: "the technology exists to support component production in [the 40 GHz band] and suppliers could readily supply components at reasonable cost." Lincoln Labs Comments, at 2. "These costs need not be prohibitively higher since...a reasonably mature technological base that can support production of 41 GHz components is already in place." Lincoln Labs Comments, at 1. "RF equipment cost will be higher but we believe the higher costs will be incremental." Id. at 4.

- Hughes, Electron Dynamics Division: "41 GHz amplifiers would be....priced approximately 20 percent higher than the equivalent 28 GHz TWTA." Hughes, Electron Dynamics Division Comments, at 1.

- TRW: "[TRW] can state with conviction that the technology that would drive LMDS at 28 GHz is not only available for 40 GHz, there is no appreciable cost difference." TRW Comments, at 7-8.

Cost of millimeter components that are different in a 28 GHz and a 41 GHz system account only for 10% of the total LMDS system cost.

- NASA: "Only the TWT used as the hub transmitter and the RF section of the subscriber receiver will initially cost more at 40 GHz, on the order of 20% for these specific components which will have little influence on the overall costs to install an LMDS network." NASA Comments, at 14.

- Hughes: "LMDS at 40 GHz would cost about 1.05 to 1.1 times as much as it would at 28 GHz." Hughes Reply Comments, at 5.

The 20% cost differential between the RF components at 28 GHz and 41 GHz translates into a total LMDS system cost differential of only 2%, decreasing to 0% over time.

VII. THE EUROPEAN EXPERIENCE DEMONSTRATES THAT 41 GHz LMDS IS TECHNICALLY AND ECONOMICALLY ACHIEVABLE

- **In 1989, the United Kingdom Radio Agency selected the 41 GHz band for an LMDS-type service called multipoint video distribution system ("MVDS"). Technical and licensing rules for analog MVDS already have been adopted in the United Kingdom.**

- **In 1990, the European Conference on Posts and Telecommunications recommended that the 41 GHz band be allocated to MVDS. 11 European countries have allocated the 41 GHz band for MVDS and 8 more plan to do so.**

  - These countries include:

Austria	Italy
Croatia	Liechtenstein
Czech Republic	Netherlands
Denmark	Norway
Finland	Poland
Germany	Sweden
Greece	Switzerland
Hungary	Turkey
Ireland	United Kingdom

- **Eurobell has been awarded a license to provide MVDS in a portion of England.**

  - The Eurobell system is divided into approximately 35 cells, with each cell serving approximately 1,500 homes.

  - Eurobell plans to use Philips Microwave equipment to deploy MVDS beginning in early 1996.

  - Analog 41 GHz MVDS equipment will become available in production quantities from Philips Microwave and GEC Marconi by August 1995.

    - Philips Microwave has made a significant investment in 40 GHz equipment. It has spent approximately 10 man years in developing the complete MVDS system.

    - Equipment is based on achieving as much commonality as possible with existing direct-to-home broadcast satellite front end receivers and indoor IF demodulator units.

- 41 GHz analog MVDS demonstration equipment is now available from Philips Microwave.

- GEC Marconi expects to have analog 41 GHz MVDS demonstration equipment available by June 1995.

- 41 GHz components are available from a number of suppliers including Farran Technology, Thompson CSF and RACAL.

- A number of other bids for MVDS franchises were submitted in the United Kingdom at the end of March 1995.

o **The cost of 41 GHz MVDS equipment is comparable to the cost of 28 GHz LMDS equipment.**

- The estimated cost for a 41 GHz MVDS analog receiver (excluding indoor set-top box) is $40.00 to $80.00.

- The estimated cost for a 41 GHz MVDS analog transmitter station is $20,000 to $35,000.

- U.K. Radio Communications Agency: "The whole concept of 40 GHz has been to keep the cost down by utilising existing standard low cost indoor satellite receiver decoders." U.K. Radiocommunications Agency Comments, at 4.

o **41 GHz digital MVDS with voice and data return links will be a reality in the near future.**

- Digital MVDS is expected to provide 300 channels in 1 GHz.

- Philips Microwave expects to have 41 GHz digital equipment available in production quantities by the end of 1996.

VIII. THE 28 GHz PROCEEDING MUST BE CONCLUDED PRIOR TO WRC-95

o **At the recently concluded 1995 Conference Preparatory Meeting, foreign delegations were critical of the United States for even considering a domestic terrestrial allocation in a band globally allocated to satellite services.**

- **Any lack of U.S. commitment to preserve existing global satellite allocations may ultimately hamper United States efforts to obtain much needed global allocations for non-geostationary satellite systems and MSS feeder links at the 1995 World Radiocommunication Conference ("WRC-95").**

- **Therefore, it is imperative that the United States conclude the 28 GHz proceeding prior to WRC-95. Failure to do so will jeopardize the United States efforts at WRC-95 to secure an adequate allocation of spectrum for non-geostationary satellite systems.**

George GILDER

TELECOSM

New low earth orbit satellites mark as decisive a break in the history of space-based communications as the PC represented in the history of computing. Pay attention to much-maligned Teledesic. Backed by Craig McCaw and Bill Gates, it is the only LEO fully focused on serving computers.

"They'll be crowding the skies."

THUS STEVEN DORFMAN, president of telecommunications and space operations for GM Hughes—the colossus of the satellite industry—warned the world of a new peril in the skies. Planning to launch 840 satellites in low earth orbits, at an altitude of some 435 miles, were a gang of cellular phone jocks and computer hackers from Seattle going under the name of Teledesic. Led by Craig McCaw and Bill Gates, they were barging onto his turf and threatening to ruin the neighborhood.

You get the image of the heavens darkening and a new Ice Age looming as more and more of this low-orbit junk—including a total of some 1,200 satellites from Motorola's Iridium, Loral-Qualcomm's Globalstar and Teledesic, among other LEO projects—accumulates in the skies. Ultimately, from this point of view, you might imagine the clutter of LEOs eclipsing the geostationary orbit itself, the so-called Clarke belt, some 21,000 miles farther out. Named after science-fiction guru Arthur C. Clarke, the geostationary orbit is the girdle and firmament of the Hughes empire.

In an article in Wireless magazine in 1945, Clarke first predicted that satellites in orbit 22,282 miles (35,860 kilometers) above the equator, where the period of revolution is 24 hours, could maintain a constant elevation and angle from any point on Earth. In such a fixed orbit, a device could remain for decades, receiving signals from a transmitter on the earth and radiating them back across continents.

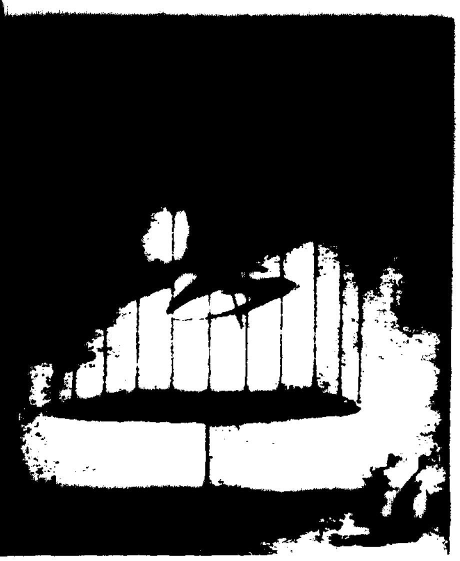
The Clarke orbit also posed a problem, however—the inverse square law for signal power. Signals in space attenuate in proportion to the square of the distance they travel. This means that communications with satellites 22,000 miles away typically require large antenna dishes (as much as 10 meters wide) or megawatts of focused beam power.

Now, however, a new satellite industry is emerging, based on gains in computer and microchip technology.

Illustrations: Chris McAllister

These advances allow the use of compact handsets with small smart antennas that can track low earth orbit satellites sweeping across the skies at a speed of 25,000 kilometers an hour at a variety of altitudes between 500 and 1,400 kilometers above the earth. Roughly 60 times nearer than geostationary satellites, LEOs find the inverse square law working in their favor, allowing them to offer far more capacity, cheaper and smaller antennas, or some combination of both. Breaking out of the Clarke orbit, these systems vastly expand the total available room for space-based communications gear.

It is indeed possible to "crowd" the Clarke belt—a relatively narrow swath at a single altitude directly above the equator. But even this swath does not become *physically* congested; collisions are no problem. The Clarke belt becomes crowded because the ability of antennas on the ground to discriminate among satellites is limited by the size of the antenna. Spaceway and Teledesic both plan to use the Ka band of frequencies, between 17 gigahertz and 30 gigahertz, or billions of cycles per second. In this band, reasonably sized antennas 66 centimeters wide can distinguish between geostationary satellites two degrees apart. That's some 800 miles in the Clarke belt. Thus no physical crowding. But it means that there are only a total of 180 Clarke slots for Ka band devices, including undesirable space over oceans.



On May 27, Dorfman summoned the upstarts, McCaw and Daggatt, to Hughes headquarters in Los Angeles for a talk. Missing was Bill Gates of Microsoft, a company that in 1993 temporarily surpassed the market value of General Motors, Hughes's owner.

LEOs, however, can be launched anywhere between the earth's atmosphere and a layer of intense radiation called the Van Allen Belt. The very concept of crowding becomes absurd in this 900-kilometer span of elevations for moving orbits that can be 500 meters apart or less. Thus the 21 proposed orbital planes of Teledesic occupy a total of 10 kilometers of altitude. At this rate, 70 or more Teledesic systems, comprising some 65,000 satellites, could comfortably fit in low earth orbits.

Nonetheless, it was clear that the LEOs, one way or another, were crowding Hughes. Hughes commands satellite systems or projects that compete with every one of the LEOs. Hughes responded to the threat of Teledesic by announcing the expansion of its Spaceway satellite system, then planned for North America alone, to cover the entire globe. Then, invoking the absolute priority currently granted geostationary systems, Hughes asked the Federal Communications Commission to block Teledesic entirely by assigning Spaceway the full five gigahertz of spectrum internationally available in the Ka band.

On May 27, Dorfman summoned the upstarts, Craig McCaw and Teledesic President Russell Daggatt, to Hughes headquarters in Los Angeles for a talk. Busy with Microsoft—the Redmond, Wash., company that in 1993 temporarily surpassed the market value of General Motors—Teledesic partner Bill Gates did not make the trip. But as the epitome of the personal computer industry, his presence haunted the scene.

Together with Spaceway chief Kevin McGrath, Dorfman set out to convince the Seattle venturers to give up their foolhardy scheme and instead join with Hughes in the nine satellites of Spaceway. Not only could Spaceway's nine satellites cover the entire globe with the same services that Teledesic's 840 satellites would provide, Spaceway could be expanded incrementally as demand emerged. Just loft another Hughes satellite. Indeed, Spaceway's ultimate system envisaged 17 satellites. With "every component proprietary to Hughes," as Dorfman said, the satellites only cost some $150 million apiece. By contrast, most of the $9 billion Teledesic system would have to be launched before global services could begin.

Nonetheless, the new LEOs marked as decisive a break in the history of space-based communications as the PC represented in the history of computing. Moreover, Teledesic would be the only LEO fully focused on serving computers—the first truly "global Internet," as McCaw's vice president Tom Alberg depicted it. It brings space communications at last into the age of ubiquitous microchip intelligence, and it brings the law of the microcosm into space communications.

If you enjoyed the New World of Wireless on the ground—with its fierce battles between communications standards, technical geniuses, giant companies, impetuous entrepreneurs and industrial politicians on three continents—you will relish the reprise hundreds and even thousands of miles up. Launching Teledesic, McCaw and

Gates were extending bandwidth abundance from earth into space. Observers, however, often did not like what they heard.

Bad Press for Two Billionaires

EVERY SO OFTEN, the media is taken by the notion of technology as a morality tale. In place of a gripping saga of unjustly obscure geniuses enriching the world by their heroic creativity in the teeth of uncomprehending bureaucrats and politicians, the media treat technology ventures as a school for scandal. We have mock exposés of computer hype, monopoly, vaporware, viruses, infoscams, netporn, securities "fraud" and deviously undocumented software calls. Pundits gabble endlessly about the gap yawning between the information rich and the information poor, thus consigning themselves undeniably, amid many yawns, to the latter category. While American market share climbs near 70% in computers, networks, software and leading-edge semiconductors, analysts furrow the brows of the Atlantic Monthly with tales of farseeing foreign teams, spearheaded by visionary government officials, capturing the markets of American cowboy capitalists. They spiel implausible yarns of tough-minded trade warriors prying open the jaws of Japan for Toys "R" Us, closing down vicious Korean vendors of low-priced dynamic RAMs, or blasting through barriers to U.S. telecom gear in the Tokyo-Osaka corridor, saving the day for Motorola's soon-to-be cobwebbed factories for analog cellular phones.

One of these sagas began early this year with two Seattle billionaires, McCaw and Gates, allegedly boarding McCaw's sleek yacht and going on an ego trip. With McCaw pitching in an early nickel, and the boat, and Gates hoisting his name as a sail, the two tycoons seemed to sweep away from the shores of rationality, as the media told it, into a sea of microwaves and arsenic. Spinning out Teledesic to build an information superhighway in the sky, they proposed to strew the heavens with 840 satellites, plus 84 spares. All would whirl around the world at a height of 700 kilometers (435 miles), using what they told the FCC would be some 500 million gallium arsenide microchips to issue frequencies between 20 and 60 gigahertz from some 180,000 phased-array antennas. The entire project seemed suffused with gigahertz and gigabucks. "We're bandwidth bulls," says Teledesic President Daggatt.

In case the hype of the sponsors failed to keep the system radiant and aloft, fueling it also would be a total of 12,000 batteries fed by thin film solar collectors stretching out behind the satellite "birds" in some 130 square kilometers of gossamer wings. Working at 4% efficiency, these cells would collectively generate 10 megawatts of power, enough to light a small city, but, so the critics said, insufficient to reach Seattle at microwave frequencies in the rain. (The Teledesic frequencies are readily absorbed by water in the air.) To manage the elaborate mesh of fast-packet communications among the satellites and ground terminals, the constellation would bear some 282,000 mips, or millions of instructions per second, of radiation-hard microprocessors and a trillion bytes or so of rad-hard RAM. In effect, Teledesic would be launching into space one of the world's largest and most expensive massively parallel computer systems.

At a mere $9 billion, to be put up by interested investors, Teledesic's lawyers told the FCC, the price would be a bargain for the U.S. and the world. (By contrast, current plans call for $15 billion just to lay fiber for interactive TV in California.) But former Motorola, now Kodak, chief George Fisher—fresh from pondering numbers for the apparently similar Iridium projects—suggested that $40 billion for Teledesic would be more like it. (Teledesic had the improbable result of making Iridium's 66-satellite plan, greeted in 1990 with much of the scorn now lavished on Teledesic, seem modest.) Just rocketing the 840 satellites into orbit was said to entail a successful launch every week for a year and a half at a time when hoisting satellites is still a precarious and sometime thing.

Even if Teledesic succeeded in getting the things up, so other scientists suggested, the satellites would then be impaled on some 7,000 pieces of space debris in the chosen orbits. In any case, so it was widely reported, 10% would fail every year, some tumbling out of orbit, others joining the whirl of litter, where they would fly ready to impale the remainder of the satellites and the remnants of the two billionaires' reputations.

Surely these sages know that by the year 2001, when the systems would be up and running, the world will be swimming in the bandwidth of "information superhighways." Why support this lavish launch of technology for a communications system that would be dwarfed by capabilities already demonstrated on the ground?

Summing up a near-consensus of critics, John Pike, director of the Federation of American Scientists' Space Policy Project, declared to the Wall Street Journal, "God save us. It's the stupidest thing I've ever heard of!" Provoking Pike may have been the origins of the multisatellite architecture in the Star Wars "brilliant pebbles" program. Teledesic's most amazing achievement to date has been to displace the Strategic Defense Initiative as Pike's peak example of stupidity.

While McCaw and Gates could be dismissed as tyros in the satellite field, Hughes is world champion. Since 1963 the company has put 107 communications satellites into orbit. With 19 in 1994, this year should be its biggest ever. In 1993, well before the Teledesic announcement, Dortman announced the first version of Spaceway—a $660 million two-satellite system offering voice, data and video services—as a contribution to "information superhighways."

In the midst of all the terrestrial uproar surrounding superhighwaymen Al Gore, John Malone of TCI, Raymond Smith of Bell Atlantic and scores of other telco and cable

	 Globalstar	 [illegible]	Winner and Loser
Number of Satellites	48	66	More and smarter satellites means more capabilities for Iridium.
Cost of System	$1.8 billion	$3.4 billion	Globalstar cheap and efficient: Indium gets little for the money.
Altitude	750 miles	483.3 miles	
Spectrum Request	Operates in "L" band (1.2 to 1.6 Gigahertz) and the "S" band (2 to 4 GHz). Can share with other CDMA systems.	"Give us the spectrum." TDMA requires exclusive allocation in "L" and "Ka" (20 to 30 GHz).	Globalstar's CDMA spectrum sharing ability is big winner.
Money Raised to Date	$275 million	$1 billion	Iridium big winner to date; but Globalstar needs far less.
Airtime Charge per Minute	30 cents	$3	Globalstar big winner.
Terminal Cost	$750	$2,500	Globalstar big winner.
Uses	Mobile voice, fax and E-mail	Mobile voice, fax and paging	Both systems target same market, but Iridium great in the Arctic.
Antenna Size	Three feet	Six feet	Globalstar more efficient.
Expandability	Capacity per beam times number of beams times frequency reuse factor. Globalstar can increase number of beams, number of satellites, and with CDMA reuse all frequencies everywhere.	Under TDMA, Iridium frequency reuse factor is 1/7 and airborne intelligence does not benefit from ground advances in microchips.	Globalstar is most expandable because of simple "bent pipe" architecture where most of system stays on the ground, and because of CDMA 100% frequency reuse.
Launch Weight	390 kg, 800 lbs	700 to 800 kg, 1,540 to 1,800 lbs	Globalstar lightest bird.
Spectrum Sharing	Yes	No	CDMA allows spectrum sharing; TDMA requires spectrum exclusivity, though can share by segmentation.
Modulation Scheme	CDMA	TDMA	CDMA allows superior performance for mobile voice and narrowband data communications, but awaits chip learning curve to yield cheap teleconferencing and computer video.
Spectrum Band Used	"L" band, "C" band (4-6 gHz), "S" band (2 to 4 GHz)	"L" & "S" bands.	Iridium uses "S" band for intersatellite links.
Regulatory Advantage	Spectrum sharing and use of ground infrastructure	Corporate clout at Motorola. Hurt by need for exclusive spectrum in crowded "L" band and by ground system bypass technology.	Globalstar can share spectrum and use local facilities.
Intersatellite Links	No	Yes	Globalstar's bent pipe is far cheaper and simpler. Iridium gets expense without bandwidth and is loser.
Rollout Date	1998	1998	Globalstar's simpler, more tested system may well be ready first.
Backers	Alcatel, France Telecom, Deutsche Aerospace, Vodafone and other local service operators.	Mitsui, Kyocera, DDI, Great Wall, Khrunichev, Mawarid, Lockheed, Raytheon	Iridium's backers have put up more money; Globalstar's backers are local exchange carriers that will offer the services.
Learning Curve	Simple technology with capabilities that will advance with Moore's Law, the progress of microchips and mobile computing	Iridium will also advance with Moore's Law, but since the intelligence of the system is in space, it cannot be readily upgraded before it is replaced.	Globalstar will advance more readily with the advance of the microcosm on the ground.
Time to Download Jurassic Park ([illegible], MPEG 2)	6,945 hours @ 4.8 kbps	6,945 hours @ 4.8 kbps	Try Direct Broadcast Satellite (DBS).
Cost to Download Jurassic Park	$125,010	$1.25 million	Both of these are narrowband systems, ill-adapted to video or teleconferencing.
Time and Cost to Download Daily New York Times ([illegible])	3.47 hours, $82.51	3.47 hours, $825.10	You may not want to get your Times this way either.
Bottom Line: Capacity and Cost			Globalstar commands 10% more capacity than Iridium at half the system cost.
Law of the Telecosm	Globalstar offers cheap bandwidth the ethernet of satellite systems. Suffers from initial lack of broadband capacity.	Iridium offers great concept but high-expense, low-bandwidth system.	Globalstar is the winner—more capacity, less cost, and spectrum sharing. Should Motorola join Teledesic.

magnates, however, no one paid much attention to Hughes.

Then came Gates and McCaw with Teledesic and claims of 20 million potential subscribers, two million simultaneous connections, billion-bit-per-second "gigalinks," bandwidth on demand and an array of other features, all advertised at a cost for Spaceway-type services nearly three times lower per bit per second. Everyone noticed Teledesic.

At the end of July, though, Hughes raised the stakes. With successful launches under way in China, Brazil and French Guiana to provide exclamation points, Hughes made a new submission to the FCC, extending Spaceway into a nine-satellite global system costing $3.2 billion. McGrath plausibly claimed it could be in place long before Teledesic and offer nearly all its functionality at a third of the price.

Already planned to be in place by 1998, however, were several other LEO projects, led by Motorola's Iridium and Loral-Qualcomm's Globalstar. As mobile phone projects, these systems could not readily offer service at T-1 data rates. But their sponsors promised availability for simple E-mail, faxes and paging.

By mid-1994, Motorola seemed to command the financial momentum. The company succeeded in raising some $800 million in equity investments from companies around the globe, including Lockheed and Raytheon (which would build the satellites), Great Wall of China and Khrunichev Enterprises of Russia (which together would launch a third of them), the Mawarid Group of Saudi Arabia (which pitched in $120 million) and Kyocera, Mitsui and DDI, which together put up another $120 million. (Kyocera will build the dual mode handsets for Japan and DDI will sell and service them.) On August 10, an Indian consortium purchased a 5% stake and a seat on the board for $38 million. Motorola claimed its share of the equity was dropping to 28.5%, well on the way